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ABSTRACT

The principal concepts and processes of long-range technological forecasting is reviewed to reveal some omissions of strategic planning and to assess the way it is applied to postsecondary education. It is argued that strategic planning in higher education generally lacks the methodological rigor of long-range technological forecasting. A major process within strategic planning (environmental scanning) lacks structure and an understanding of where and why the tools of forecasting are appropriately used. The concept of technology transfer space is addressed. Within an eight-level hierarchy, the use of forecasting tools is fitted to the technology transfer space. These tools include Delphi, extrapolation, morphological analysis, contextual wrapping, and analogy. The relationship of strategic planning to technological forecasting and operational planning is shown. Definitions of 10 concepts are included. Appended are questions appropriate for exploratory and normative concerns within each level of the technology transfer space. (Author/SW)

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STRATEGIC PLANNING OR TECHNOLOGICAL FORECASTING? THERE'S A DIFFERENCE!

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STRATEGIC PLANNING OR TECHNOLOGICAL FORECASTING? THERE'S A DIFFERENCE!

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Introduction and Purpose

Recent research (Meredith, Cope, and Lenning, 1987) confirms that, although 87% of selected universities claimed to be engaged in strategic planning, as few of one-third of these institutions were actually conducting "bona fide" strategic planning. Instead, "a large proportion of administrators and planners appear to equate strategic planning with traditional long-range planning or just about anything considered management." (p. 4) The discrepancy can be attributed not only to the generality of the definitions of strategic planning, but also to the ambiguity of structure and process, and to what Helmer and Rescher (1963) blamed on the lack of methodological rigor in planning for the inexact sciences.

Two recent AIR-sponsored publications (Uhl, 1983; Morrison, Renfro, and Boucher, 1983) provide excellent discussions of the concepts and processes of strategic planning. While Glover and Holmes' (1983) article surveys a rich variety of possible sources of externally-developed forecasts, the major implication seems to be that higher education institutions should conduct their own forecasts using the environmental scanning process. The probability

is that only very few universities would have the capability or commitment to muster and maintain such an effort.

The development of a forecast of physical, human, and social technologies relevant to the comprehensive missions of universities is mind-boggling in scope. There are others more skilled to such work: the think tanks (RAND, Hudson and Gallelle Institutes), the business and corporate groups, and individuals (Clarke, 1963; Chase, 1970; Diebold, 1969; Kahn, 1976; Meadows, et al, 1972; Masuda, 1980). Glover and Holmes (1983) emphasized that even institutional researchers have neither the knowledge nor time to produce balanced futures forecasts or monitor the relevant environments for several schools or university functions. Certainly, a team of faculty representatives selected to conduct ongoing environmental scanning would not tolerate such a demanding detraction from their primary interests for long.

The more appropriate role of institutional researchers and faculty teams is in the processes of reviewing, integrating, and extracting the relevant aspects of forecasts, then assessing the probable influence of those technological developments to their institution's future. The more proper function of environmental scanning within universities should focus on evaluating the external (political, economic, social) and internal (missions, programs, personnel, facilities, and funding) environments as those might facilitate or inhibit changes in the

institutions missions (and how it pursues them) as influenced by technological adoption or adaptation.

More intensive, inclusive, and regularized involvement of the faculty and administrators follows the review of forecasts and the institution's environmental scanning. This occurs as strategic choices are established and disseminated through policy, and policy is translated into programs which are planned for in the five-year and annual planning cycles.

Long-range technological forecasting (LRTF) is a complex of concepts, processes, and techniques which has been used for decades by business, government, and military. When I served as superintendent of schools for the Creole Petroleum Corporation (then the major overseas subsidiary of Standard Oil Company of New Jersey) in Venezuela during the 1960's, their forecasts for exploration, drilling, refining, and marketing were all done on a 20-year time frame, with incremental planning on five-year and annual cycles. Indeed, every executive employee had an individualized five-year plan. Corporate life and its future depends on the quality and precision of forecasting; the processes and tools used have undergone rigorous refinement, because the stakes are so high.

As I read about current strategic planning activities in higher education, the old saw about "putting new wine in old bottles" keeps coming to mind. Meredith, Cope, and Lenning (1987) found that most universities seem to have put

the new "strategic planning" label on traditional planning practices. What can we learn from the long-range technological forecasting practices which can be applied to strategic planning, to improve its quality and rigor and give us more reliable products as we search to find our way into the future?

A review of the principal concepts and processes of long-range technological forecasting can help to reveal some of the apparent omissions of strategic planning, and possibly improve what we are attempting to do in shaping the future of postsecondary education. Following is a discussion of the definitions and concepts involved, and the framework of the technological forecasting.

Definitions and Concepts

Long-range technological forecasting is grounded on ten fundamental definitions and their related concepts:

1. Technology has been considered as the driving force which influences cultures, societies, organizations, and individuals in changing what they do and how they behave (Ellul, 1964; Jantsch, 1967; de Jouvenal, 1967; Ackoff, 1974; Gabor, 1970; Piele, Edell, and Smith, 1970; Daedalus, 1967; Kahn, 1976; and Masuda, 1981). However, technology is considered to include inventions and innovations which are physical, human, and social in nature. In fact, much of what we find as technologically-induced change is a combination of

the three--some physical (e.g., machine, pharmaceutical) change combined with its influences on people and how they work and live. Innovation on existing technology (much more so than invention, or discovery per se) is a dominant aspect of what we produce under the research mission of universities, usually driven by government and foundation funding.

2. Technological forecasting is the process of identification and assessment of current and future technological developments, including an assessment of their probable impacts on organizations and how we work. (Jantsch, 1967; Martino, 1975) Of interest in the forecasting process is the probable rate of growth of the technology, its potential magnitude (influence), possible facilitators or deterrents to its development (including both technical and normative considerations), and its interfaces with other technology. The possible range of technological evolution is phenomenal, since "modern" society expects and depends upon change as the motor of social and economic development. Further, since ours is a relatively unplanned, uncoordinated society, technological change occurs randomly, with unpredictable and often undesirable consequences. Changes in a particular technology

influences another, and these trigger secondary and tertiary impacts.

3. Technology transfer is a principal concept which provides the process framework for technological forecasting. The following section of this paper elaborates upon the technology transfer space, an eight-level framework which enables those involved in forecasting to trace and explore the development and application of technology, in this case those with particular relevance to our universities.

4. Alternatives and their probabilities for technological development, and their potential for influencing how we carry out our missions, is emphasized in forecasting. Whereas the technical possibilities for development of an innovation are most appropriately done by experts in the topic of interest, explorations of the probable impact and influences on a particular organization are the proper domain of those who work in that organization. Technical development forecasts are done by technicians; applications possibilities are done by those who will use the technology.

Forecasting is probabilistic in nature. The emphasis is on generating a rich and extensive diversity of possible alternatives for both development and application, each with judgments

about associated probabilities. Each alternative can be oriented either on a particular work situation, or to an institution-wide perspective. All possible ideas are accepted, at least at the beginning: The final forecast will eventually discard most of the alternatives generated, and retain only those with probabilities of 80-85% or greater. Estimates of the probable time requirements for development or application also should be included. Brainstorming, as originated by Osborne (1963) is a fruitful technique to use to reduce the agenda of either the technical development or applications possibilities. Eventually, however, each option must be tested against the realities of the constraints of the real world. Criteria such as time requirements, cost, feasibility, probable impact, acceptability, and capability of our personnel to learn and use the technology are used in screening and selecting alternatives.

5. Exploratory forecasting is primarily a technical process. It involves both an examination of the "engineering" aspects of a technology and professional judgments about its potential development and evolution. Those who are technically expert in the innovation under consideration are the primary contributors to

exploratory forecasting. This phase focuses on whether the innovation can be developed (or modified, adapted, integrated, etc.)--its feasibility. Since a technology under consideration might be human or social, as well as physical, the "engineering" experts who produce the exploratory forecast might be from the "soft" sciences and humanities, as well as from the fields of "hard" sciences.

The time orientation of exploratory forecasting is from the present to some date in the future. Much of the current technological forecasting uses the year 2000 as a target date. Assessments are made of the past history of a technology and its developmental trend, with expert judgments about the technical requirements which will contribute to its future evolution. Since the profit incentive is a primary motivation for much of physical technology development, this type of innovation is more abundant in modern (capitalist) societies. Human technology might be directly influenced by physical technology innovations (as in the case of new drugs), but most human and social (organizational) innovation derives from changes in physical technology. Examples might include the use of computerized systems for university registration, counseling,

library searching, academic tutoring, and communications. Improvements in the technology, coupled with dramatic decreases in the cost of equipment and software influence how quickly the institution adopts technological innovations to carry out their essential activities.

6. Normative forecasting is an opposite orientation for the assessment and evaluation of technology. Where exploratory forecasting is concerned with the technical requirements and feasibility of technological development, normative forecasting focuses on the desirability of such development--should it be done? Normative forecasting begins at some long-term target date in the future. Those involved in an organization create a model or scenario of what they aspire the organization to be like and the nature of its activities. This is not done in isolation from probable future technological developments, but instead emphasizes how the institution's missions and activities can be enhanced and enriched in positive (and value-influenced) ways by technological applications. The description of the idealized future condition and characteristics of an organization is shaped by values (which also evolve through time). Normative forecasts are not fatalistic, as if technology and its influences

were inevitable; they are optimistic and opportunistic. Where the Environmental Protection Agency standards and The U.S. Congressional Office of Technology Assessment require assessments of possible future technology impact, individual institutions can also create such normative forecasts.

Social scientists, including philosophers, psychologists, sociologists, and others whose primary expertise and interest is the public and environmental welfare can contribute significantly to normative forecasting.

7. Interface and feedback are provided best when exploratory and normative forecasts are created together, in a unified environment. Consensus between the technicians and the social welfare experts is essential to produce a forecast which will be widely accepted.

Jantsch (1967) has provided a model of the interface and feedback processes where exploratory and normative forecasting are done concurrently (Figure 1). Technical constraints on technology development--both limitations on what can be done and what should be done are clarified when the interface occurs. As institutions carry out their long-range plans, feedback provides information which influences the modification of both

forecasts and implementation plans on a cyclical basis.

8. Forecasting tools include an extensive variety of means by which particular data or development can be shown within a forecast. Again, Jantsch (1967) provided an array of these tools. (Figure 2) Some are difficult to clearly dichotomize as appropriate for either exploratory or normative forecasting; some can be used in either approach. The important contribution is that there is a great variety of tools, from highly quantitative to purely judgmental, which are used in long-range technological forecasting.

9. Technology assessment is the dominant process used in forecasting. Mayo (1971) described the process as:

> . . . the sum of the processes whose purpose it is to identify the full range of effects (direct and derivative; immediate, intermediate, and long-term) of technologies or technological applications and to evaluate the social desirability or undesirability of such effects (p. 2).

The Appendix to this paper includes sets of typical questions which could guide either individual or collective effort in technology

assessment. First, a set of pre-technology assessment questions helps clarify the situation and its participants. Then, sets of questions are provided for each of the eight levels of the technology transfer space. Finally, the last figure shows questions appropriate for follow-up on a technology assessment.

Technology assessment might be focused on domains, particular elements, or the confluence of developing technologies. Domains could be broadly encompassing areas such as microcomputers, communications systems, or distance marketing of educational programs. Particular elements could include the hardware, software, and procedures for conducting on-site ERIC database searches; a departmentally-based computer-assisted program for tracking and advising students, and for planning faculty workload and space scheduling as derivatives of the student records system; or an on-line database and related institutional research services to serve management functions. The confluence of technological innovation often produces dramatic breakthroughs with synergistic effects far greater than the sum of the components. The Batelle (1973) study demonstrated how significant technical and non-technical events contributed to the creation of high-order

technology, such as the heart pacemaker, input-output analysis, and the videotape recorder.

10. Forecasting and planning are sequential activities. In relative order, the forecast of technology is prepared first. Its product is a statement of the nature and probability of technological development with (if normative considerations have been involved) implications for societal application and impact. It describes how and to what extent a technology might develop, often with the associated resources (time, money, effort) necessary to facilitate the process. The forecast is fundamentally oriented to the evaluation of probable technology development and application, and also should explore the potential effects on work, the individual, the workplace, and social groups. This should include a balance of judgments by experts in both the hard and soft sciences.

The technological forecast serves as the basis for institutional decisions about priorities for the future, and should influence creation of the strategic plan. That plan is a statement of intent about what the institution will became by some long-range date, influenced by the organizations values, beliefs and aspirations. The strategic plan is holistic in its orientation;

the details of what will be done and how are developed later in the five-year and annual plans. The sequence from technological forecasting through annual planning and implementation shown in Figure 3. Feedback throughout the sequence is the process by which our inexact science of integrating technology in beneficial ways for organizational improvement is corrected in process. Since we cannot foresee the future with exact certainty, we forecast and plan for evolutionary changes through incremental stages. The evaluation phase, which assesses how well one has achieved what was intended, derives from each aspect of the strategic plan. The product of the strategic plan is a global description of intended organizational change, with critical milestones toward progress and performance criteria identified. The strategic plan shapes institutional policies on programs, personnel, resource allocation, and delivery systems. Next, intermediate-range plans are developed, usually in five - or ten - year increments. At this stage, the policies and institutional directions for change are translated at the tactical (college and departmental) levels into programs. Program and performance objectives are specified, and detailed resource requirements are identified. Finally,

operational plans are developed on an annual basis. Annual plans are much more specific, including targets for achievement, detailed resource requirements, and descriptions of how the objectives will be achieved. After these are screened and approved, the plans are carried out and evaluative performance data gathered. Feedback from the evaluations influences all phases of the forecasting/planning cycle, and redesign might be needed at any phase. Then, plans are rewritten and implemented again, in a continuing iterative cycle.

The Structural Framework of Forecasting

The development and application of technology has dominated the history of human and social development. The great difference in our period of history is in the quantity and rate of growth of technology, with correspondingly shorter diffusion times. New technological developments in modern societies quickly become pervasive because enormous effort is dedicated to its development (often by research universities) and marketing. Acknowledging the serious social effects sometimes caused by technology, it has clearly improved the quality of life and work. Driven by the search for efficiency and response to social need, technology development has become a core activity in modern societies, and expectation of change and improvement through

scientific (technological) applications has become an important theme in our value systems.

Our postsecondary education systems are basically more reactive than proactive to technology. As technological changes surface, we are challenged more to search for appropriate applications after the fact than to foresee and attempt to influence technological development. Forecasts and their subsequent strategic plans which relate to our identified problems in higher education would be a much more productive approach to finding how best to integrate technology into what we do, than our current reactive behavior.

Because technological development is so pervasive, and because the growth in its volume and shortening of its diffusion time have become so accelerated, we need more systematic ways of assessing technology to find how best to apply it to improve what we do. The technology transfer space as a structure for developing forecasts, and the technology assessment process as a framework for exploring information can contribute to more rational and scientific evaluations of the future and what we do in it. Jantsch (1967) began his comprehensive overview of forecasting with the concept of the technology transfer space (Figure 4). It provides a structure for exploring technology, with four levels of development and four levels of application. The process of innovation begins with ideation, as we become aware of some new scientific information, and we interpret

or extrapolate from that in some new way. At the second level, that idea is combined and related with other knowledge, to develop the conceptualization more fully. This process probably involves many, many reconfigurations as the concept is refined. The conceptualization of the new technological idea is submitted to some sort of laboratory verification at level III. Even an idea about the reorganization of an educational delivery system can be tested in alternative ways. When one or more preferable alternatives are found, they are developed into prototype models in the last level of the development phase. More than one prototype model might be created.

The prototypes are field-tested at level III to assess how well they perform in real-world conditions. Feedback from field testing is used to redesign and improve the technology, and it is recycled back through the field testing stage, often several times, until it is sufficiently refined to perform acceptably on a wider scale. The technology usually is developed in response to a specific need in a particular organization. The refined technology as then marketed (but not always necessarily for profit, since it might be a new technique or organizational form) throughout that market sector (level IV). As its successful performance becomes more generally known, the technology is diffused and disseminated to other sectors in level VII. Often, modifications and adaptations are needed, and the technology is recycled back through the development levels.

In this way, variations of the technology became much more pervasive, and are applied in new ways. This stage is also particularly important because the confluence of various technologies produces variations which are often dramatically different from those first developed. Finally, in level VIII, the technology is widely diffused throughout society and produces changes in how we work, our relationships, and even how we think. Note that the exploration process of technology assessment sometimes involves synthetic reasoning, as in levels I, III, and VIII of the technology transfer space (Figure 5), and involves primarily analytic processes in the other levels. The technology transfer space can be entered at any level. In fact, most practitioners in postsecondary education might not become aware of developing technology before the first application level (field testing). Within one's particular academic discipline, we often hear of innovations at the prototype development stage, however. Within one's specialization, the process of manipulation and generation of knowledge produces ideas and conceptual development for technology development at stages 1 and 2, When team efforts are applied to technology assessment, evaluations are generally limited within the four applications levels of the transfer space.

The Appendix to this paper includes sets of questions for the technology assessment process at each level of the

technology transfer space. These are only suggestive in nature. The appropriate aspects to be considered would have to be developed for any unique technology assessment. Included is a set of questions to use at the beginning, before the assessment is initiated, and another set of questions for the follow-up to the process. The technology assessment, applied within the technology transfer space, produces the forecast. That becomes the basis for an institution's strategic plan when those involved search for and elect choices which will shape the organization's future development.

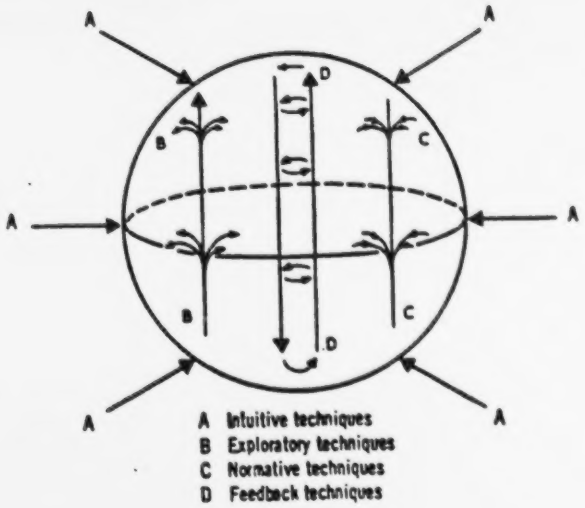


FIG. 1. Exploratory and normative forecasting with feedback. Source: Jantsch, Technological Forecasting in Perspective.

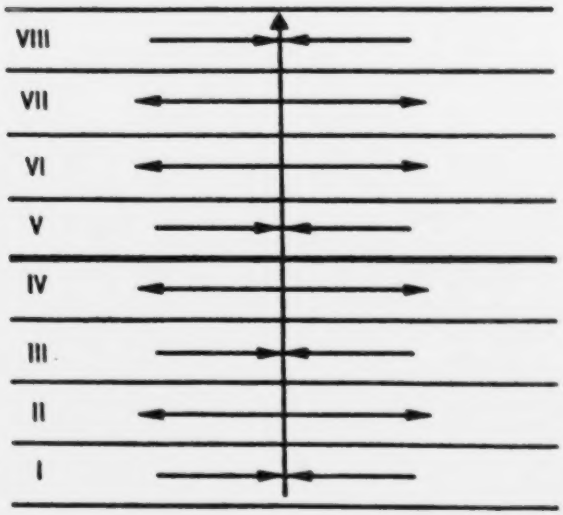
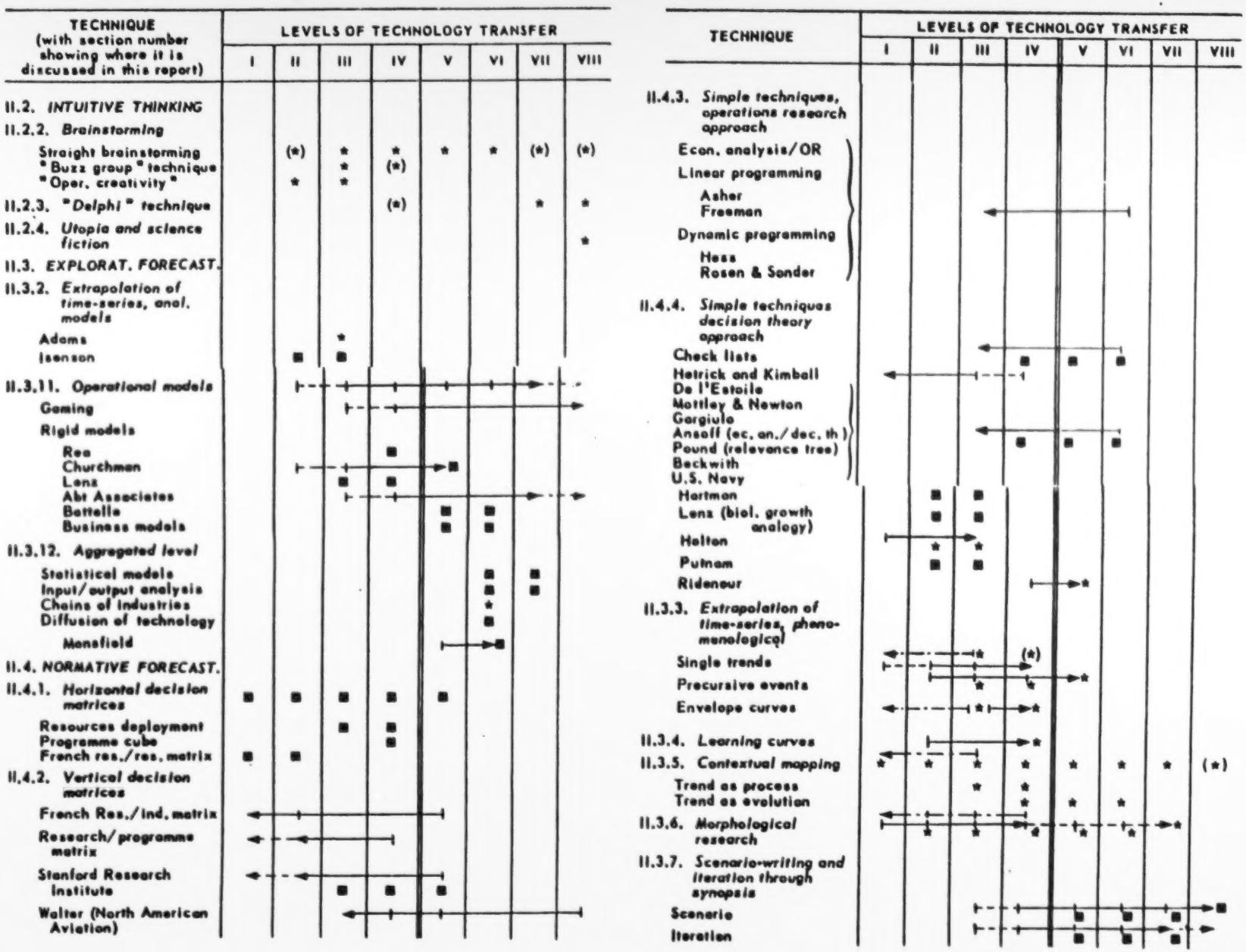
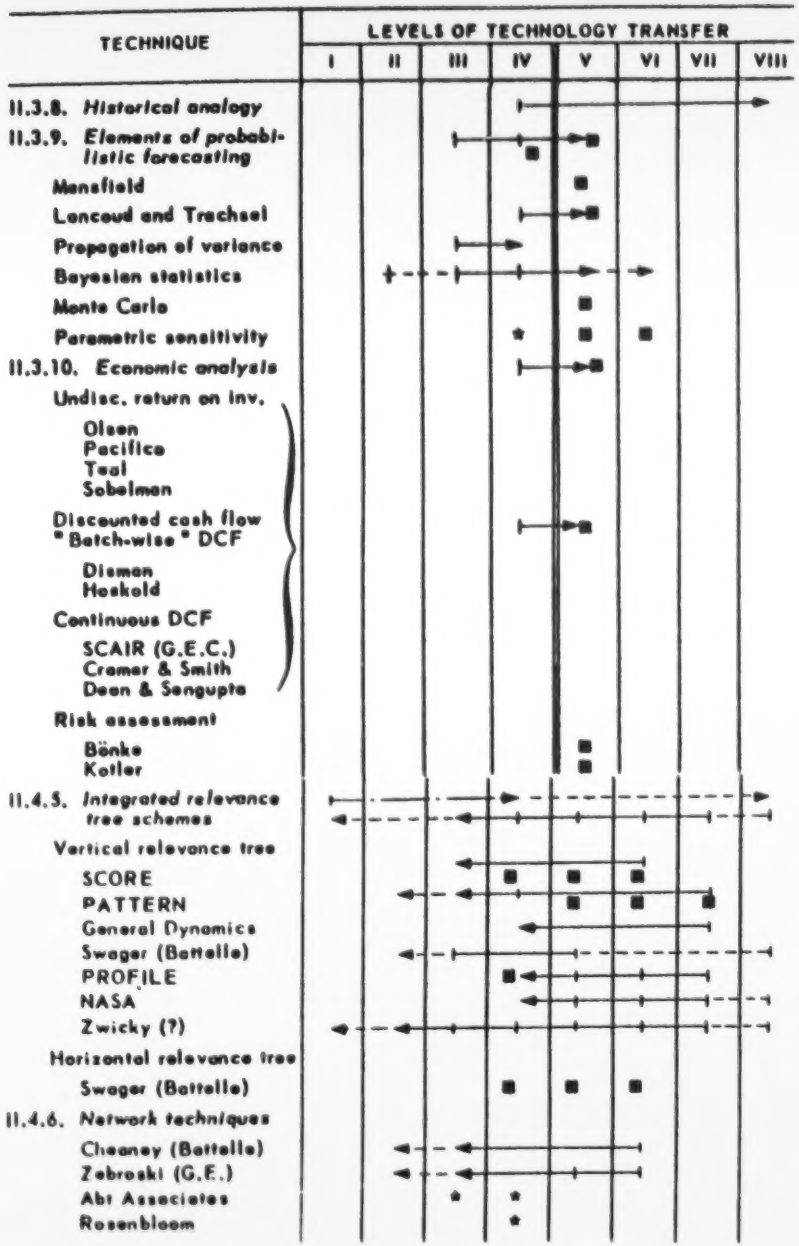
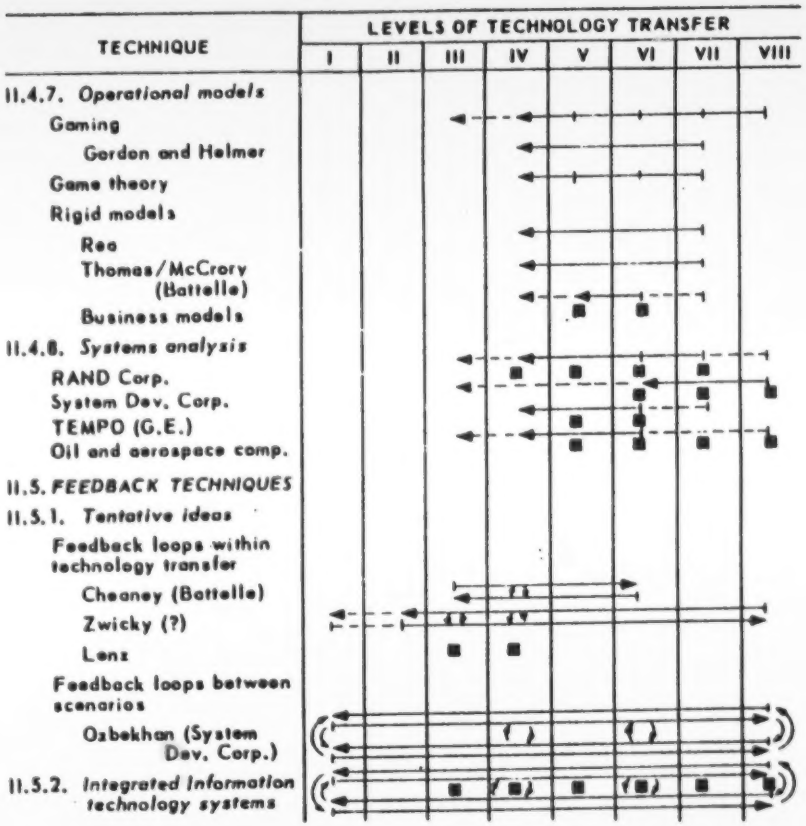


FIG. 5. Analysis and Synthesis Processes in the Technology Transfer Space. Source: Jantsch, Technological Forecasting in Perspective.



23 FIG. 2. Forecasting Techniques in the Technology Transfer Space.
Source: Jantsch, Technological Forecasting in Perspective. 24

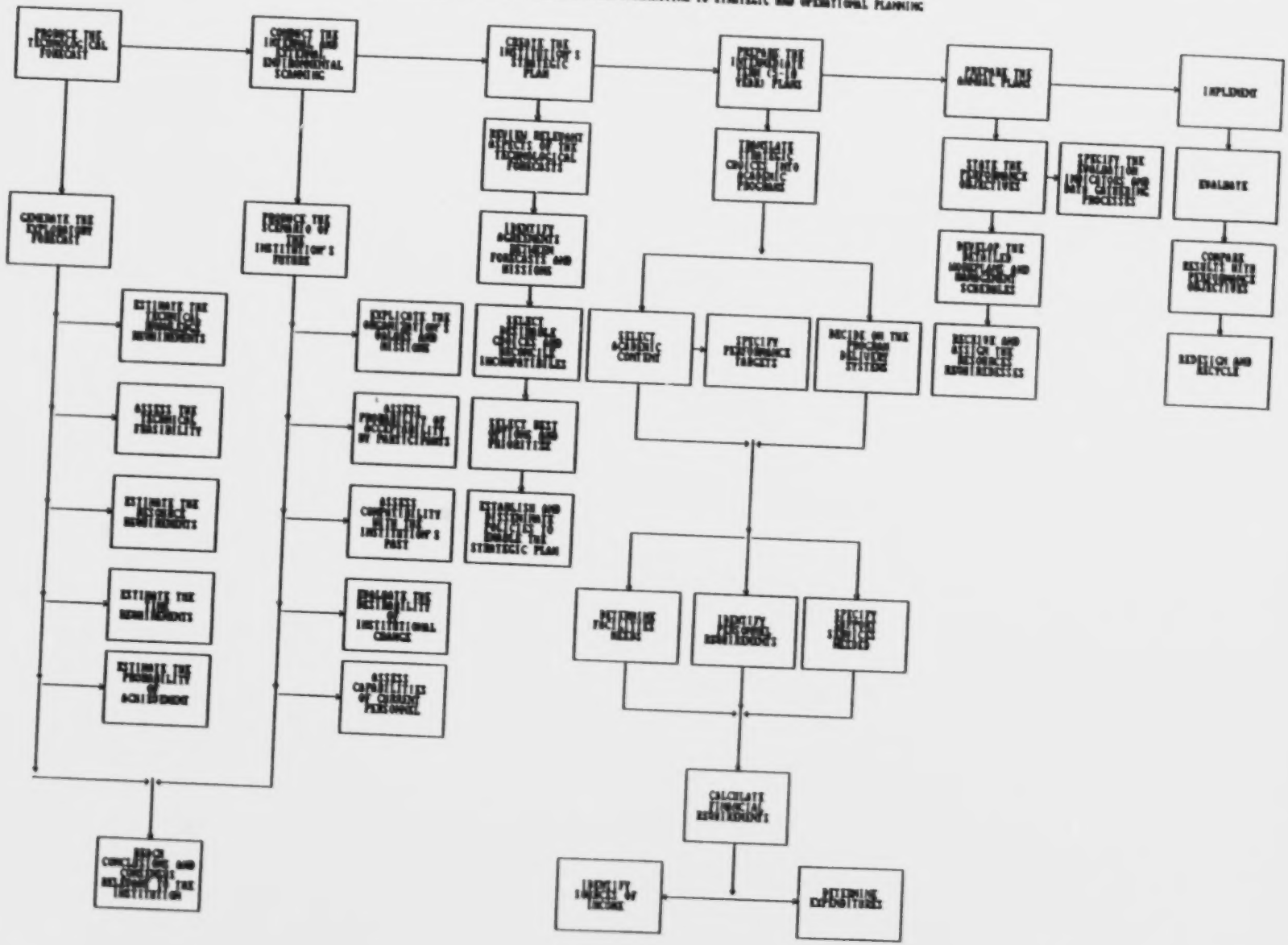




The following graphic signs are used in the table

* (*)	Level of (isolated) application (with brackets : doubtful or less formal)
■	Substantial combination with horizontal factors
----+----→	Direction and penetration of transform method (vertical marks : individual evaluation for that level possible ; dotted line : uncertain)
←- - - - - -	Strong stimulation for (human) feedback

FIGURE 3. RELATIONSHIP OF TECHNOLOGICAL FORECASTING TO STRATEGIC AND OPERATIONAL PLANNING



APPLICATION	VIII.	SOCIETAL IMPACT	The technology is broadly diffused and applied throughout society. TA analysis explores how the technology has influenced structures and behaviors in the social, economic, political, and environmental sectors.
	VII.	PROLIFERATION	The technology is disseminated to other environments and applications. Adaptations and adoptions are made for uses other than that for which the technology was originally intended.
	VI.	MARKETING	The technology is refined following field tests and made available through some marketing process, either for profit or not.
	V.	FIELD TESTING	The technology prototype is tried out in some specific applications and populations under variously structured control conditions. Feedback from field testing suggests modifications/ improvements prior to production.
DEVELOPMENT	IV.	PROTOTYPE DEVELOPMENT	Initial laboratory verification of the technological concept leads to the development of a working model for physical technology and refined processes for non-physical technology.
	III.	LABORATORY VERIFICATION	The ideas and concepts are initially tested in some form of laboratory proofing.
	II.	CONCEPT AND PROPOSAL DEVELOPMENT	The fundamental idea is combined in a number of configurations with relevant knowledge and technology from associated fields to generate conceptualization of how the idea might be translated into practice.
	I.	IDEATION	The basic idea is created either as an original discovery or an innovation upon existing ideas or practices.

FIG. 4. The Technology Transfer Space (after Jantsch)

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APPENDIX

1. Does timely baseline data exist on social/economic/political/ecological environments? Will it be available to the TA team?

2. What is the agreed-upon definition and description of this technology?

3. What or who motivated this TA? What special interest views are involved?

4. For which decision-makers will the TA be conducted?

5. Who will participate on the TA team? Are divergent points of view and disciplines represented? Is each member of the TA team knowledgeable about the environmental baseline data?

6. Is this technology and its application likely to become a major national issue?

7. Is sufficient relevant knowledge and data available to enable assessment of the technology under study and its impact?

8. Will the assessment be of manageable scope? Can it be bounded within reasonable limits?

9. What is the estimate of the probability that the TA can be done?

10. Will the TA make a contribution?

11. How much time will probably be required for the TA?

12. Will this TA complement or aid in other projects or TA's?

13. What is the likelihood of governmental regulatory action as a consequence of this TA?

14. What will be the probable cost of the TA? Can the budget be adhered to reasonably?

Pre-TA Decisions

LEVEL 1 - IDEATION/DISCOVERY/INNOVATION

EXPLORATORY QUESTIONS

What could be the causatives (and identify type--economic, social, etc.) that will lead to the creation of this idea/innovation?

Are there existing parallels between the ideation of this technology and other potential but as yet unconceptualized technologies?

What preceding technological knowledge might contribute to the creation of the new technology?

Might this new idea/innovation be the product of the confluence of other technologies?

What external factors, if any, might assist or inhibit the development of this technological idea?

In what ways can the milieu be conducive to ideation?

What is the relationship between this new technology and causative technologies?

Are there normative or exploratory forecasting products with potential to contribute to ideation of new technology in this field?

What is the probable time between initial thought and realization of level two (the conjunction of this idea with other knowledge to result in concept or hypothesis development?

Are there conditions of freedom/independence which can facilitate the creation of new ideas or innovations? Conditions which are restrictive/limiting which might foster their creation as a manifestation of rebellion?

NORMATIVE QUESTIONS

Can any applications of this new invention/innovation be imagined which will positively enhance the realization of societal goals?

Can conjecture be made regarding this technology's beneficial or detrimental character? More specifically, are any areas of impact foreseeable at this early level?

Should the technological idea or innovation be rejected or should it move to the next level?

Does this invention/innovation seem to contribute positively to the normative goals of the group/organization?

LEVEL 2 - CONCEPTUALIZATION AND PROPOSAL DEVELOPMENT

EXPLORATORY QUESTIONS

What additional technological knowledge must be added to the idea from level one to form the conceptualization and hypotheses at this level?

What is the status of technologies relevant to this one? R&D stage? Under development? In use?

What modifications must be made in the evolution of the concept/hypothesis and why?

What are the foreseeable applications of this technology?

What time might be involved in formulation of the concept/proposal of level two?

What external influences (pressures, market opportunities, problems) in any way might contribute to inhibiting, modifying or promoting development at level two?

Will supplementary or supportive technologies be necessary for continued development? Will these supplementary technologies have any socio-economic impact? Identify.

What modifications of the original idea or innovation (as created in level 1) might be necessary in order to fit it to other relevant knowledge and technologies?

From which domains of disciplines of knowledge are related concepts probably available to be drawn to conjoin with this new idea or innovation?

What will be the necessary conditions (costs, personnel, equipment, etc.) before realization of level three: laboratory verification?

NORMATIVE QUESTIONS

Is there any potential for impact of this technology on existing technologies?

Should the development of this technological idea or innovation be continued or be rejected completely?

Are the probable costs of further development worth the effort?

If any parallels are discerned, what judgements can be made regarding the probably success or failure of development of this technology to subsequent levels within the transfer space?

What controls or stipulations might be attached to the conceptualization and why?

Are there any discernible interferences to the development of this technology through the transfer space levels ahead, and what impact would those inhibitors probably have?

Where might this concept/hypothesis be placed on a continuum of desirable to undesirable, in the normative sense?

LEVEL 3 - LABORATORY VERIFICATION

EXPLORATORY QUESTIONS

What special preparations will be necessary for laboratory verification of the technological concept/hypothesis?

What other technologies will be utilized in the process of laboratory verification? How will each contribute?

What new technologies must be developed before laboratory verification can be realized?

What confluence with other technologies may be forecast to enable laboratory verification?

Do those new technologies needed to enable laboratory verification have potential for impact on other sectors or technologies?

If the technological concept/hypothesis is rejected at this state of development, what are the fundamental factors (misassumptions, misinformation, etc.) contributing to this?

What is the estimated time requirement between the conceptualization or proposal development at level 2 and the completion of laboratory verification?

What effect might existing or as yet undeveloped technologies have on this technology?

What effect will competing technologies have? What modifications should be made in this technology to increase its competitive advantage?

Are competing technolcgies recognized at this point?

What controls might be imposed on further development of this technology as a result of what was learned during the laboratory verification process?

Will the process of laboratory verification probably cause any other new ideas/innovations/concepts/hypotheses to be created?

Are other technologies and processes available or apparent which will be necessary for the development of functional prototypes or expanded technological systems?

NORMATIVE QUESTIONS

What normative factors (economic, political, environmental, personnel, etc.) had to be achieved in order to enable laboratory verification?

What effects can be discerned that the new technology will have on existing technologies?

What is the probability of acceptance of this technology by potential users? Is that judgment unbiased?

What normative inferences (possible impact on quality of life, value systems, etc.) emerged during the laboratory verification process?

Should the technology proceed to level four of the transfer space or should it be returned to a lower level or rejected completely?

Are any special preparations (economic, physical, environmental, political, etc.) necessary before proceeding to the next level?

LEVEL 4 - PROTOTYPE DEVELOPMENT AND DEMONSTRATION

EXPLORATORY QUESTIONS

How might the prototype differ from the conceptualization or laboratory verification model or process? What modifications could be made and why?

If it is necessary to return the technology again for laboratory verification, what could be the contributory factors?

What technical requirements (materials, cost, trained personnel, etc.) are probably necessary to complete prototype development?

Is the new prototype compatible with existing technologies? What effect might it have on existing technologies? What effect might it have on future technologies?

Might there be any unanticipated factors which could have led to modification and how could these factors be identified at an earlier stage? Are those factors primarily technical or normative in nature?

Are any new technologies necessary to enable prototype development in level four?

Are supportive technologies available to facilitate successful completion of field testing with this prototype at level five?

What existing technologies might be utilized in development of the prototype?

What is the probably time requirement for the development of the prototype?

Do parallel technologies exist? How competitive will they probably be with this technology?

What modifications can be forecast to afford wider application of this technology (e.g., to modify and enhance other existing technological systems)?

NORMATIVE QUESTIONS

Is the probability of social acceptance of this technology favorable? If not, what modifications or preparations first must be made?

What impact (economic, social, environmental, political, etc.) might the use of supplementary technologies have?

What social, political, economic, etc. significance can be foreseen if this technology were to be fully developed and marketed?

Is there a need for personnel training or education to enhance optimal utilization of this technology?

Could this be a substitutive technology? If so, how might it affect jobs, markets, work patterns, social groupings, etc.?

What will the adoption and diffusion rate of this technology probably be?

Who or what agencies have supported the development of this technology through the R&D stages? What was their motive for support?

What has been the nature and extent of publicity about this technology?

What technical or normative factors (environmental, policy, impact on value systems, etc.) must be considered before proceeding next to field testing?

LEVEL 5 - FIELD TESTING

EXPLORATORY QUESTIONS

What method of evaluating the results of field testing will be used? Is this method valid? Will the data be confidential?

What controls or delimiting structures will be imposed at this level? Are those controls technical or normative in nature?

Is further confluence with existing or future technologies possible to enhance the achievement of objectives with this technology?

Are there now other technological parameters which must be imposed before proceeding? Are they feasible?

Might the new technology conflict with existing or future technologies in these applications?

What is the estimated time duration of the field testing?

Will there be existing parallel technologies field tested at the same time and how do they compare?

What reactive tasks and modifications will possibly need to be undertaken before commercialization and marketing at level six?

Would the best decision be to abort the technology following the field testing? Return it to a lower level of development?

What is the spectrum of all possible applications which can be forecast for this technology? What refinements will be necessary to fit the technology to other applications? Which of the other applications has highest potential for success?

What needed changes in service functions should be looked for in this field testing? Can the user system probably respond to effect those needed changes?

What possibilities for horizontal integration of this with other technologies are included in the field testing?

How will evidence of needed product improvement for this technology be collected during the field testing?

NORMATIVE QUESTIONS

Upon what segment of the population will the new technology be tested? How will they be chosen and why?

If conflict exists between this and existing technologies, what is the nature and impact of this conflict?

What is the probable impact of this technology on the individual (life style, perspectives, attitudes, morality, values, etc.) studied during the field testing? Will some of these be affected more dramatically than others?

Are there any residual effects, either anticipated or unanticipated, of the technology? If there are unanticipated effects, how could they have been identified at earlier stages?

Can other impacts (primary, secondary, or tertiary) be forecast at this point?

What might be the impact of this technology on the community (relationship of individual or family to it, structure, functioning, attitude, political climate, value system, etc.) and how will these be assessed during the field testing?

What monitoring system for this technology will be most effective?

What will be the socio-economic implications of this or a modified technology?

Was external evaluation used for the field testing assessment?

LEVEL 6 - COMMERCIALIZATION

EXPLORATORY QUESTIONS

What methods of commercial introduction will be used (sales techniques, marketing policies, information dissemination, etc)?

What future confluence is possible for this technology with other technologies to enhance and extend commercialization?

What new technologies should be developed and at what cost to assist in marketing this technology?

What structural modifications are needed (legislative, policy, organizations, etc.) to enable commercialization of this technology?

What new technologies might be developed to complement, supplement or replace this technology?

What other technological developments in related sectors might prove to be facilitative for further growth of this technology?

What further technologies could be developed to enhance or perpetuate this technology?

In what ways could monitoring or controlling (statutory or policy-induced) affect the marketing of this technology?

What is the estimated duration of the commercialization phase to the level of substantial usage?

What are the possible forces or events which might make the technology more or less successful (costs, time, attitudinal, etc.)?

How will the initial market acceptance be planned? What contingency modifications might be necessary, desired or possible?

How can evidence be gathered to determine whether this invention/innovation might be used as a substitutive technology?

What are the probable marketing costs (shipping, advertisement, sales, inventory management, etc.)? How will those costs be monitored?

What modifications of other technologies (physical, social, or human) can be forecast which might maximize the effectiveness of the commercialization of this technology?

Will acceptance of this technology be limited to certain groups, classes, segments of the population? Are there any attributable factors?

NORMATIVE QUESTIONS

What is the potential impact of the use of this technology on the individual, the family, the community and society in general if its commercialization is successful?

What effect will controls (legal, policy, attitudinal) have upon this technology?

What unanticipated events or forces might have major effect on this technology and its commercialization?

What degree of acceptance can be anticipated? Can any limiting or qualifying factors of acceptance be perceived?

What value changes among users can be forecast which will be required to enhance widespread usage of this technology?

What specific societal functions (education, transportation, food supply, etc.) can be forecast to benefit from this technology?

Which societal groups or labor force sectors will probably feel the greatest impact of this technology?

At what point in the commercialization process should decisions be made to increase production? to phase out?

What commitment has the developer made to long- or short-term commercialization of this technology?

With which population group (affluent, poor, developing nations, etc.) is there greatest potential for benefit from the applications of this technology?

What is the probable demand on natural resources if this technology becomes widely used through successful commercialization?

LEVEL 7 - PROLIFERATION AND DIFFUSION

EXPLORATORY QUESTIONS

With what other technologies might this technology combine? Can those combinations be identified specifically, both in terms of nature and form of combination?

Are there any controls or restrictions (legal, policy, attitudinal) which might inhibit the diffusion of this technology to other sectors?

What are the potentials for effect of this technology on existing or new technologies?

What will be the configurations of the technology after adaptation or adoption of this technology on other sectors?

What can be forecast as the probable duration of the diffusion of this technology to other technological sectors?

What degree of control is possible by the developer over the proliferation of this technology to other sectors? Are the copyrights or statutory provisions adequate to ensure control over the proliferation/diffusion process?

What conditions can be forecast which will be inhibiting, and what conditions will be facilitative or proliferation/diffusion of this technology to other sectors and applications?

Has a forecast been completed to identify a reasonably complete set of possibilities for the recombination/reconfiguration of other technologies with this technology?

What are the identifiable consulting and advising opportunities for the developers of this technology to facilitate its transfer to other applications/sectors?

Is the nature of this technology such that it might be adopted by direct transfer to other applications with minor modifications, or will it be preferable to sell licenses/rights on the technology and thereby permit adaptation/modification by other producers?

NORMATIVE QUESTIONS

What resultant impacts might affect the proliferation of this technology from seemingly unrelated or unforeseen events or forces? What strategies can be developed to minimize and control those impacts if they are negative?

Which direction might the impacts of proliferation of this technology take to incite innovation or ideation of other technologies?

What unexpected diffusion of this technology might take place and with what possible socio-psycho-economic results?

What will be the effects, anticipated or unexpected, on other sectors (social, educational, medical, etc.) than that for which it was intended?

Might there by any counter-trends or reactions against either the technology, the technological mutants or the impact of the technology?

Are there any secondary or tertiary effects (socio-economic, etc.) of widespread proliferation of this technology to other technical sectors?

What are the probable social costs (value changes, social organization, etc.) of the proliferation of this technology to other sectors?

LEVEL 8 - SOCIETAL IMPACT

EXPLORATORY QUESTIONS	NORMATIVE QUESTIONS
What might be the beneficial or detrimental impacts of this technology on the reactive technologies--those developed in response to this technology?	How dramatic will be the impact of this technology on the individuals, groups, institutions, and larger society?
Can the probable societal impacts of this technology be forecast? How do these compare with parallel or counterpart technologies?	What controls can be forecast over this technology and what effect might these controls have? Who or which organization will administer those controls?
What are the probable demands of this technology on the resources of the producing organization?	What ethical implications will the technology and its impact have on society/individuals?
	What new legislative or regulatory possibilities could affect the social impact of this technology?
	What impacts on the environment can be forecast from applications of this technology?
	What future technologies probably will be developed as reactions to the impacts of this technology?
	What demands will the technology have on the natural resources?
	What is the potential socio-economic impact that the complementary, assistant, substitutive or resistant technologies might have on the social impact of this technology?
	How does the list of negative societal impacts resulting from the application of this technology balance with the list of positive effects?
	What social impacts and effects can be forecast as a result of applications of this technology, expressed in terms of their probability, magnitude, duration, and social desirability? What is the probably aggregate effect of these?

FIG. 3 Exploratory and Normative Inquiry Framework Fitted to the Technology Transfer Space.

1. Have all of the probable horizontal transfer opportunities (mergers, demands, diffusions, adaptations, invasions, etc.) for this technology been identified for this level?

2. Are all of the probable detrimental as well as beneficial effects identified? How do these balance?

3. What recommendations can be forecast for new standards (health, safety, etc.) which should be developed?

4. What probable secondary and tertiary impacts can be identified at this level of the transfer space as a consequence of the impact of applications of the technology?

5. Has the necessary development and testing been completed at this level of the technology's development to provide the essential starting requirements for transfer to the next level vertically in the transfer space?

6. What probable effort requirements (personnel, funding, policies, equipment, etc.) will be necessary before the development of this technology can proceed to the next vertical level?

7. If the probable effort requirements can be met, what are the estimated time requirements to complete the next level of development vertically?

8. What probable effects can be forecast for this technology if development can be successfully completed at the next level?

9. What precursor events can be identified as necessary to the transfer of this technology to the next level?

10. Given the understanding of the technology and its potentials at this stage of development, is continuation, modification, deferral, or termination recommended?

11. Can the probable beneficial and negative effects of this technology, as identified in this and prior levels, be combined to yield a systemic assessment?